

BROADBAND REPEATER FOR ULTRAWIDEBAND TECHNOLOGIES

Abstract

In the coming years, ultrawideband (UWB) transmissions will dominate high data rate communications in the last 10 meters of wireless/portable access. With the huge data rates afforded by UWB, offices, homes, and small environments such as doctors offices, vehicles, or small buildings will rely on UWB communication devices for connections between consumer electronic devices and computer devices. The proposed invention provides a low cost infrastructure solution for connectivity of devices that avoids the need of more expensive network hubs or access point routers required in today's WiFi/WLAN networks.

Background of the Invention

As UWB devices proliferate, it will be possible to provide immense data rates, at burst rates up to 480 Megabits per second and even greater, in order to create a wireless Universal Serial Bus (USB) capability. This will allow cameras, cellphones, computers, and computer and home entertainment and video systems to have very good and fast data rate transmissions in small (say 10 to 20 to 30 feet) distances. The great data rates of UWB will open up an entire new world of high speed personal area networks which currently does not exist. Companies such as Time Domain, Xtreme Spectrum Inc, Motorola, Intel and Texas Instruments, are likely to be leading manufacturers or developers of Intellectual Property for UWB communications.

In typical doctors offices, homes, apartment buildings, and large rooms, etc, today there are Wireless (WiFi) access points that can be connected to the ethernet backbone in order to provide WLAN access and internet access to computer platforms. The backbone medium is typically Cat-3 or Cat-5 cabling that has 10baseT, 100baseT or 1 GHz ethernet signaling. In the future, this backbone may be wireless, for example, where cable companies or telephone/wireless/internet service providers may use mesh networks or last mile MIMO modem devices that bring broadband video, audio, and data/internet traffic to homes from lampposts or street corners.

Today, the expense of the WiFi access points is on the order of several hundred dollars when the hardware and installation is factored in. These access points provide the ability of multiple WLAN users (typically computer or PDA users) to gain portable access the internet, and hot spots such as those implemented by Schlotzsky's Deli and Starbucks are becoming popular throughout the world. However, these WiFi access points are made to allow users to access the internet, which is a different use and approach than is likely to emerge with UWB networks, which connect devices together in piconets.

In future UWB applications in the home or office, it is likely that only one or two devices, such as a computer, a server, or a television set or game console, will be connected to the ethernet/internet backbone, while many other devices, such as home entertainment systems, telephones, portable computers, and display/video/audio/entertainment devices in the home or office will be untethered within the same room or within several feet of these "fixed" internet-connected devices. In hospitals, hotels, or homes and offices and businesses, the UWB technologies will open up an entirely new way of communicating high data rate, and will create entirely new architectures for communications within small spaces. In vehicles, trains, aircraft, and other moving platforms, one can envision a single or a few main devices connected to an outside wireless internet connection, while in the vehicle itself, piconets will be formed between UWB devices.

Ultrawideband technologies are about to become mainstream, and are described in US patent application 20030096578, published May 22, 2003, by John McCorkle, et. al. of Xtreme Spectrum, Inc., as well as in "Recent Applications of Ultra Wideband Radar and Communications Systems, by Robert Fonatna of Multispectral Solutions, Inc. The IEEE 802.15.3 standards bodies

have been developing Physical (PHY) and MAC layer standards for dynamic channel selection and repeater service for UWB, which falls under the general IEEE 802.15.3 standards body.

As explained in the powerpoint presentation by Nishant Kumar, of Virginia Tech' MPRG, as well as in the IEEE standards proceedings, the IEEE 802.15.3 MAC operation provides for "repeater service request" and "repeater service grant" commands. Devices use passive scanning to listen for beacon frames or for any nearby user device. If there are not nearby devices which are radiating, a device may establish its own piconet. There are a number of frame and superframe structures, and subsections which permit various types of access, such as contention based schemes using, for example, carrier sense multiple access (CSMA), as well as guaranteed time slots for asynchronous or isochronous data streams and management time slots.

While the MAC standard suggests repeater service to be used by IEEE 802.15.3 devices when the links between devices are not satisfactory, these types of links can only be established if there is sufficient time available in the channel seen by one of the devices which is involved in the repeating operation. As proliferation of UWB devices is likely to be rapid, there is likely to be contention such that the current mode of MAC repeater operation, envisioned by the presently proposed 802.15.3 standard, is not adequate to provide one or more of sufficient security, proper traffic filtering, bandwidth provisioning, network management features, or flexibility of networks that can be installed or controlled easily by a consumer. That is to say, the current repeater operation contemplated by 802.15.3 and proposed UWB devices is based on the assumption that a single chip can perform necessary repeater functions, which will not be adequate for the rapid emergence of UWB that is certain to occur.

UWB adaptation is likely to be rapid, and just as spam mail occurs today with increased frequency on the internet, wireless UWB devices will be subject to tremendous and increased amount of interference, spam traffic, and RF interferences, as well as security attacks by rouge or spoofed message sources or unwanted transmitters. Proper "repeater" functionality will require the ability to detect and process such unwanted traffic in a personal area network, as well as to report back attempted breaches of security or interference sources to a network controller or host device which is connected to the internet (for example, the home computer or game console). The need to properly process, filter, ensure security, and provide sufficient or prioritized bandwidth will also emerge because of future wireless networks that will allow devices in the home or office to remain connected to the outdoor wireless network through roaming systems and protocols, as proposed by Dong-Ho Cho in US Patent Application 2002 0198977 Published December 26, 2002, and other networks such as those described by Rappaport in "Wireless Communications: Principles and Practice, 2/e, c. 2002 and the invited 50th anniversary paper by Rappaport, et. al., "Wireless Communications: Past Events and Future Perspectives," June 2002, IEEE Communications Magazine.

Currently, IEEE 802.15.3a, the Ultrawideband Physical Layer standard committee, is working on creating a standard that may either be Multiband OFDM transmission, with 500 MHz channels, or a Direct Sequence Spread Spectrum impulse radio standard that has broader channel bandwidths. Ratification of one or both of these standards is likely to occur by the end of 2003, as described in a recent paper submitted to High Frequency Electronics -- paper attached with this application along with the references which appear at the end of the paper.

The High-Tech article by Woz Ahmed and Bipin Parmar (the Chilli) provides a glimpse at the various activities in the Ultrawideband standard bodies. Ultra-Wideband Technology was also discussed in the New Technology Bulletin in March 2001, Vol. 1, Issue 7, before the multiband OFDM proposal was created. In fact, Time Domain's Paul Withington presented the talk "Time Modulated Ultra-Wideband to the Federal Wireless User's Forum in May 2001. As described by Robert X. Cringely in his August 8, 2002 article, "Good News!", it was mentioned that Xtreme Spectrum had already produced a working UWB chip capable of 100 megabits per second over 10 meters, and the article further explained the idea of mesh networking, which will provide

efficient network paths that allow very high data rates across the internet for remote downloading of files.

In "Ultrawideband.ca Mesh Networking Explained", Ultrawideband.ca explains they have software that allows a user to install, on their PC, a MeshBoot disk which attempts to find internet gateways at particular Internet Protocol addresses using a DHCP client. If no gateway can be found, the software causes the users' PC to simply serve as a wireless repeater-cell. This type of operation is controlled by the software on the CD, and requires installation by the user. In future years, there are parallels that can be drawn between some of the features and functionality in the MeshBoot software for Internet use, and the capabilities that will be required to be embedded in network hardware, rather than provided on a CD for installation on PCs, in order to support massive amounts of traffic in and around homes and offices (Rather than on the world-wide internet). This patent application describes a new type of network device that will be required as wideband UWB devices proliferate rapidly.

Summary of Invention

In anticipation of the increased traffic, ubiquity, security and bandwidth provisioning needs of future UWB devices, we have invented a low cost repeater that is tailored for easy and rapid deployment to facilitate the interconnection of ultrawideband devices, which will likely be standardized in 2003-2004 time frame. The invention described here is a low cost repeater device, which allows a home or office user to rapidly deploy a repeater which can extend the range of these UWB piconets, so that a home or business owner does not have to install wiring such as Cat -5 cable throughout an office or home. Instead of wires which carry the internet traffic from today's cable or T1 or DSL jack to a particular device, the UWB repeater invented here will allow just one or a handful of internet-connected devices to serve as the "source" for a local wireless network, and the disclosed invention will enable that "source" to serve as the local hub for a whole host of portable or fixed UWB devices in a home or office.

The Ultrawideband repeater will serve to "repeat" data signals coming from one or many devices so that other devices, located farther away from the "source" will be able to access the internet via the repeater. This will obviate the need for any wiring whatsoever in homes and offices, and will enable rapid deployment of networks beyond the standard range of stock UWB equipment. The repeater will provide for additional coverage and will enable high data rate channels to work in confined environments more efficiently and more reliably than stock UWB equipment. That is, the invention here offers advantages, flexibility, and improved performance and security than the currently proposed IEEE 802.15.3 activities which call for "repeater service" as part of the MAC definition.

The Ultrawideband repeater invented here has the additional features of being able to filter and process data, and to provide for the storage, processing, and forwarding of received data at the input, and also allows for the suppression or "killing" of data that is not part of the desired network or which may be from undesired users, spammers, or interference sources. Also, the ability of the receiver to prioritize traffic access and flows, based on application requirements, make this invention a powerful device used to enable high bandwidth personal area networks, where a number of wireless devices in a home or office all share the same UWB spectrum without requiring wiring, but which may have different real time requirements, different priorities and bandwidth requirements, and different security requirements. Thus, the intelligence of the repeater, afforded by processing, storage, and antenna/RF control is a marked improvement over what is currently contemplated or known.

Detailed Description of the Invention, including preferred embodiment

Repeaters are well known in the art, and they have been manufactured for decades in the cellular and PCS industries, and more recently, a company in Melbourne FL, WiDeFi has developed WiFi

repeaters for the IEEE 802.11a/b marketplace (See WiDeFi web pages describing their patent pending designs for range and bridge extension for Wireless LAN standards). Buffalo Technology announced a bridge and repeater product for IEEE 802.11g wireless LAN WiFi standard on June 17, 2003 (See SmallNet Builder website page), and indicated that its repeater provides point-to-point or 6 station point-to-multi-point operation. Buffalo indicated it had security features such as WiFi Protected Access (WPA), WEP, Password protection, and MAC address association control. It uses a browser based interface for configuration, and has a 10/100 Ethernet LAN connection port, and sells for the suggested price of \$149. SMC Networks introduced, on June 6, 2003, its SMC2671W 2.4 GHzGHz 11 Mbps Wireless Ethernet Adapter, which provides an interface between the wired internet backbone and the wireless LAN network. It also has wireless repeater capabilities for WLAN range extension, and has both Ad-Hoc (peer-to-peer) and Infrastructure (client to AP) operating modes, WEP encryption, WPA, MAC Address filtering, and SSID Broadcast Disable. It uses a web browser or Window-based administration software for configuration. Andrew Corporation makes classic PCS/Cellular repeaters, such as the fully integrated PROPAGATOR repeater shown on its webpage. The repeater uses standard 110VAC power and has a single package for all signal processing components.

Our invention differs from prior art because of the much greater bandwidth of UWB, and the presently unforeseen challenges and unmet solutions that UWB and the massive amounts of traffic will provide. Our invented repeater architecture solves a critical problem for future high speed UWB networks, and provides needed network coverage, performance, security, filtering, addressability, configuration, and connectivity for a home or business personal area network. The invention provides needed network infrastructure to provide coverage where only one or a few sources are linked to the ethernet backbone (or the central server/hub), while providing embedded security and traffic intelligence. The invention helps connect the rest of the UWB equipped devices through a repeater operation for other devices that may exist in a room or office. In this way, for example, a doctor's office would only need to have a single computer, say the receptionist's desk computer, which might be connected to the internet or which would serve as the host computer or server to the office network. If this receptionist's desk computer is equipped with a UWB radio, and all other devices, say portable computers, pen tablets, gaming devices, video monitors, or Voice over IP portable communicator devices used in the office, were configured to be on the same network (piconet) as this desk computer, then our invention would allow coverage and data transmission throughout the entire office, rather than being limited in range to 10 or 20 or 30 feet, etc. At the same time, the described invention provides a low cost way of providing massive data transfers, with bandwidth prioritization and security, not currently available today.

The invention is better understood after considering the following figures:

Figure 1 illustrates a Personal Area Network in a home, business, vehicle, or some other close-in space, consisting of a host device and a number of portable devices, all equipped with UWB technology.

Figure 2 illustrates a Personal Area Network in a close-in space, consisting of a host device, a number of portable devices, all equipped with UWB technology, and the disclosed UWB repeater invention, as well as an undesired neighboring transmitter.

Figure 3 illustrates a block diagram of the UWB repeater

Figure 4 illustrates another embodiment of the UWB repeater, using a more integrated approach with more reliance upon signal processing and software.

Figure 1 shows the internet connection coming into the home or office, and this "backbone" connection may be provided using wires/fiber (T1, DSL, cable, cable modem, OC3, etc.) or

wireless (last mile wireless service). Once in the home or office (or vehicle, etc.), a host device, such as personal computer or server, or building router (A personal computer, for example, is shown in Figure 1) is connected to the backbone. The host device is further equipped with a UWB transceiver, which may be integrated, stand alone, plug-in, or part of a multi-band, multi-mode radio that is connected to, attachable to, or integrated within the host device. Once connected to the backbone internet and the UWB transceiver, the host device is able to facilitate communication to other UWB devices in the home or office. For example, in Figure 1, provided that the distance is short enough and the local interference is low enough, it is possible for the UWB Transceiver on the host device to support meaningful communications to a UWB-equipped Portable Table computer, a UWB-equipped television set, a UWB-equipped telephone, and even a UWB-equipped wrist watch, all examples but not limitations of viable uses of UWB wireless technology for personal area networks. As explained in the prior art, UWB possess sufficiently high bandwidth that new services, such as ranging or position location are easily incorporated with high speed communications, and the current invention considers supporting the myriad of applications and implementations of UWB devices. Using the standards proposed in the IEEE 802.15.3 committees, it is known that it would be possible to configure Personal Area Networks such as shown in Figure 1 using UWB.

Note, however, from Figure 1, that the distances between devices vary, and the local environment may have walls or metal partitions that cause signals to decay or fade (not shown). Thus, it is possible that the host device, which is typically (but not necessarily) fixed, may not be close enough to all locations where portable users of the UWB network which to operate from at a particular instant of time. Furthermore, since the signal power falls off with distance, UWB transceivers that are further away from the host will be more susceptible to interference from undesired users or noise sources (not shown), and will also be more susceptible to security breaches or spam attacks by undesired transmitters (not shown).

Now consider Figure 2, where the same UWB network of Figure 1 now contains the invention, the UWB Repeater. With placement of the UWB repeater, the distances between the host and the repeater are shorter than the distances between the host and other users. Thus, the repeater is able to provide the ability to extend range to outlying users, which will be important to maintain high data rates in interference or crowded spectral situations. Furthermore, the repeater is also able to receive the transmissions from the undesired transmitter, and may be equipped to ignore the undesired transmission, as well as instruct other users of the network to ignore the undesired transmission, thus improving personal area network performance.

The repeater of Figure 2, in order to work properly, requires careful signal processing that is able to null out noise and interference across the very wide bandwidth used by UWB. In addition, the repeater must provide significant isolation between the input and the output, typically 40 to 50 dB minimum and more if possible, in order to prevent oscillation and feedforward interference. A wide range of techniques to perform such electrical performance are well understood by those skilled in the art of RF circuit and filter design. In addition, the UWB repeater must faithfully retransmit both the forward and reverse paths of a two way communication, and must provide uniform/even group delay across most, if not all, the occupied bandwidth of UWB.

As shown in Figure 3, to achieve fastest time to market, is to implement this invention by using two UWB chips or devices. These may be standard UWB modem devices, with sufficiently fast controlling and memory circuitry that creates a data bridge between the two UWB chips. These two chips, and the controlling/memory circuitry bridge, are built and encapsulated in a housing or chamber which has good electromagnetic isolation between the input side (the side in which signals needing to be repeated are entering) and the output side (the side in which signals that are being repeated are regenerated and reradiated). Also, an RF switch for switching/processing antennas may be integrated in the controller circuitry, or may be a separate, discrete component or series of components, such as a butler matrix circuit, simple RF single-pull multiple-throw, or phase shifter network for phased array antennas, or a wide range of well known antenna switching or phasing/processing mechanisms.

Each physical side of the UWB repeater invention may at one time serve as the input and another time serve as the output, as the invention offers simplex, half duplex, or full duplex capability. Similarly, the forward or reverse path may use either side of the UWB repeater. Antennas, such as those developed by Prof. Hao Ling at the WNCG at University of Texas, and by Warren Stutzman of Virginia Tech, allow wideband UWB transmissions with some directionality, and these are easily sprayed on or built from metal stock using metallic film on plastic cases. Dielectric antennas, or antennas with inherent notching capabilities, may also be incorporated as is known in the prior art. The directionality helps with isolation between the input and output of the repeater. Further, the repeater may use multiple antennas, in a sector arrangement, that can automatically be sensed and switched by the UWB devices and/or the controller circuitry, in order to focus energy in directions of where devices needing to be transmitted through the repeater are located. This could be used on both or either transmit or receive operations. A wideband RF switch, which may be a MEMS device such as contemplated by Hughes Electronics or Teravicta of Austin, TX, is part of the circuitry contained within the repeater, so that various antenna selections may be made. Other low-cost RF switches could be employed, as well.

As shown in Figure 4, an alternative approach to creating the UWB repeater invention, rather than using two stock UWB devices with some additional control and memory logic for data processing, signal processing, and antenna switching or diversity/beam forming, would be to use a true bent-pipe repeater approach, where all signals at the input are simply reradiated at the output. Note that the very wide bandwidths involved with UWB make this approach more difficult, yet viable in a low noise environment that does not have swamping. Even in higher noise environments, DSP noise cancellation and wideband compensation such as phase linear processing across the wideband spectrum could be employed. This type of DSP processing will be available in reasonably low cost platforms in the next several years.

Alternatively, Figure 4 represents an Application Specific integrated circuit made of Si, SiGe, GaAs, or other known materials either within a chip, a system on a chip, or discrete circuitry, could be fabricated to implement an integrated repeater with processing circuits for data processing that provides network security and data buffering as well as desired bandwidth provisioning for different applications passing through the repeater. Clearly, an integrated antenna would be a less expensive per-part product price, once the design was perfected, and a single antenna repeater with near omni-directional radiation pattern offers lower costs to manufacture, and would be more preferable for generic in-home or office use.

Note that instead of using multiple antennas, the UWB repeater could use a single antenna, and could use a vast memory to simply buffer and retransmit the received data. This would induce a greater delay in the repeated signal, but would provide a less expensive form factor, due to fewer antennas, and the lack of expense incurred with an RF switch for the antennas. A key part of this invention is the data processing capabilities afforded by the UWB Repeater.

The processing and control circuitry contains memory, which may be of a wide range of varieties and physical structured that may be on chip or on a separate chip or substrate from the processing elements of the invention. Memory may take a wide range of forms as understood by those skilled in the art, including chips, memory sticks, removable disks, etc, and this memory may be programmable, static, dynamic, optically-processed, etc. such that vast amounts of data received at the input of the invention may at any time be stored, buffered, processed, interpreted, or retransmitted. The power required for the memory may be supplied by the same power supply that powers the processor and RF components, or it may be a separately provided DC or AC power supply, depending on the particular implementation or structure. For example, if the invention were embedded in a PC, one could use a plug-in memory stick, which received power and data flows from the standard USB expansion slot, whereas the processor and UWB RF circuitry might be embedded in a chip on the mother board of the PC, itself, thereby obtaining power from the internal PC supply.

The invention allows controlling logic and the memory circuitry to either store (and not retransmit) the received data, store and forward (e.g. retransmit) the received data, ignore the received data and not store it, or store the received data and retransmit it to the originating source. Alternatively, the received data may be stored and retransmitted out of one or more antennas, including the antenna which originally received the received data. Furthermore, the data may be modified by the processing circuitry once its received, for example, to strip off unwanted or hostile data contained in the received data stream at the input of the repeater, or to add bit or packet changes in the packet data structure to implement ID or security or validation or bandwidth priority information in the repeated data which is radiated out of the repeater. Thus, the UWB repeater has the ability to monitor data which it receives, as well as to store it, forward it, return it, or modify it. All the while, the processing circuitry may be able to build statistics and observe particular behaviors of the traffic, including the ability to sniff the packets and determine desired and undesired users, attacks on the home network, , univcuvthle, EB

The capability of the UWB repeater to modify the bit streams sent and received is powerful, as future security methodologies will rely on streamlined processing to implement rapid/dynamic key changes, and to allow authentication and validation. Emerging security standards, such as IEEE 802.11i, which use dynamic keys and strong codes, as well as EAP, 801.1X, WPA, and future security techniques that may encompass both indoor and outdoor networks, will be able to be used by the disclosed invention, due to the capabilities of the processing and the modification capabilities of streams flowing in and out of the repeater. Furthermore, the repeater itself will be addressable on the personal area network, allowing the host/master device, such as the office PC or TV console, to inquire, control, and to gather characteristics of piconet users, their traffic, attacks, throughput performance, coverage performance, or unintended or intended usage through the repeater. For example, the host could access the memory for detailed data, as well as collect statistics gathered and processed and stored by the UWB repeater, so that the human user of the network could gather a report of activity. Furthermore, without human intervention, the host could gather data from the UWB device, and use that knowledge for real time or near real time control for providing security, changes in security keys or protocols, changes in bandwidth provisioning, and could even provide a termination of the home network from the internet, in order to prevent the home network from being attacked.

The ability of the UWB repeater to process data and gather traffic and network conditions, including bandwidth provisioning data and security-related data, will be extremely useful in appliances that serve as in-home or in-office network controllers and interfaces, where the Internet is connected and then served wirelessly throughout a building. The UWB Repeater disclosed here would be fully compatible with RADIUS servers, and in fact could help provide the connectivity required for home devices to gain access to the Internet, as disclosed earlier. A web-enabled interface, or windows, or some other PC or TV/VCR type programming interface could be supplied to program and control, as well as gather data from, the UWB repeater disclosed here.

The form factor of the UWB repeater may take on a wide range of sizes, shapes, and mounting/fixture options. This repeater could be installed in PCs, servers, or appliances, or it could be a stand alone device that could be purchased and placed in any home or office, much like one purchases a fire alarm or a fire extinguisher today. One could use the invention as part of AC extension cords, photocopiers, game consoles, television/video displays, etc. Fixtures, colors, shapes, and sizes may be very similar to fire alarms or air fresheners that plug into AC outlets in the home, or wired into a car DC power supply, and the repeater device may also become embedded in objects that are typically carried around the home or office, such as but not excluding cordless phones, cell phones, portable computers, home stereos,, TVs, pet collars, tennis shoes, and a wide range of portable, common devices that when moved could provide a wide array of range extension and coverage improvements of UWB devices. In fact, devices which integrate video, gaming, audio, and computing will likely benefit greatly from the disclosed invention. This invention may be embedded in AC outlets, receptacle extensions. Could become part of future phones or AC extension cords

The controller could also have memory, flash, dram, wide range of memories, to serve as a buffer-and-forward operation. One can see the embodiment of this invention to be like today's Memory Sticks that have 60 MB of memory and plug into a PC port for power -- the invention could be like this with the addition of an UWB repeater. The UWB repeater could also enable the PC or host device to connect via the UWB home network, and identify the types of traffic and priorities which should be given such traffic. Also, network management protocols and external devices and software, such as that located on the host PC, may query and retrieve the gathered data at the UWB repeater, and may adjust or control the UWB repeater processing modes for particular desired network goals -- such as greater security, more stringent prioritization on traffic, or even complete reboot/restart of processing in the UWB repeater. It is obvious to one skilled in the art that the UWB repeater could operate in concert with other devices, such as the host or other users of the Personal Area Network (e.g. home network) in order to provide distributed communication and command and control functions between the UWB repeater and other devices.

The disclosed repeater may also have security provisioning such as an "authentication" or validation, as well as non-eradication function. Depending on the particular network scenario, network assignment steps can ensure the UWB repeater is being used to "repeat" signals from only those devices which are intended to be repeated within the home or office. This functionality could be done at layer 1 (PHY) with identification or authentication code sent over the air and detected by the Repeater, or performed at layer 2 (MAC) with handshake with other devices on the network, or a combination of layers being used for the security or authentication step, or this could be performed at higher layers, even performed up at the application layer (such as with VPN, web login, telephone dial, or some other computer-controlled authentication implemented automatically by one or more devices on the network, or implemented by the user on a software interface, computer program, web site, or data entry method that connects to the home/office UWB network). Also, just as today's IEEE 802.11 bridge/repeater products, the UWB repeater may be equipped with MAC address association control, and could easily have one or more integrated wired Ethernet port connections for use on a standard wired Ethernet connection (not shown in figures). These techniques are well understood by those knowledgeable in IEEE 802.11a/b/g and 802.15.3a/b standards activities, which have become widely popular in recent years.

For example, a preferred embodiment of this invention would be mounted in an AC outlet or would be integrated in some consumer electronic device, and would be controlled by or interact with a software program running on a home computer or a game console or TV (a "host"). The host would allow the person using the home / business network to type in or use a remote control or mouse device to configure his or her own home/office network, and the network would use UWB devices to communicate with each other to provide the network, and in doing this manual configuration, the user is able to input identifiers, such as product name or manufacturing codes or some other identifier of other appliances for the home network that the user is able to enter. Of course, this operation may also occur automatically, without manual intervention by the user, by the self-configuring Personal Area network "waking up" and reading the serial numbers/device codes through the airwaves automatically, and finding the UWB repeater.

Back to the manual example, in doing this data entry, the user is implicitly setting up security features which allow the myriad devices in the home to know they are on the desired network, and the UWB repeater is then able to know, through shared knowledge of this security information, which devices should be "repeated" and which devices (say from a neighboring building) should be "ignored" and not repeated. In this example, the UWB repeater could be embedded within the PC or cable TV product, or it could be communicated to wirelessly or via cable by the home computer or cable TV product, or it even could serve as the host, itself, where it is connected to the internet using wireless or wired means. Of course, one can imagine the invention also having no security or more limited security, where some or all messages within earshot would be repeated by the UWB repeater, or which some messages would not be

repeated due to inherent knowledge of local devices and their valid signaling or data transmission.

In addition to security features disclosed above, the UWB Repeater has bandwidth provisioning controls, so that some users (such as portable email or low rate data or low rate audio) are allocated some delay, or less important priority, in being retransmitted than are high priority data, such as video data or voice over IP telephony, or high bandwidth messaging or urgent information which has less tolerance to delay. This quality of service (QOS) intelligence could be identified within the MAC, PHY, IP and/or other layers of the UWB protocol, or in some other manner which allows the UWB Repeater to prioritize and provision certain repeated data over other repeated data. For example, data bits which alert the repeater and the network to the particular type of user/device can be used to help prioritize the UWB repeater's processing of the data which is to be repeated. In fact, the UWB repeater could be used in network test, where the memory and controlling circuits are used to induce a fixed, known, preset, or desired delay on particular traffic which is received by the repeater, in order to test "ringing of the network" or to determine if attackers or interference is correlated with the operation/transmissions of particular devices on the PAN.

It is clear to one skilled in the art that the above disclosed invention may be applied in a wide range of applications and configurations as captured in the scope of the appended claims.